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4.5 Synchronization of distant Laser stations thanks to Time Transfer by Laser Link : Proposal for a dedicated campaign

A. Belli (1,2), P. Exertier (1), E. Samain (1), C.Courde (1), J.M.Torre (1), F. Vernotte (2)

(1) Géoazur Valbonne, France

(2) Observatoire de Besançon UTINAM, Besançon, France

The high performance of the Time Transfer by Laser Link (T2L2) space experiment (on-board Jason-2) has been demonstrated by several campaigns from 2012 up to now. The principle was to observe the satellite in Common View (CV), which ensures the benefit of using quasi-simultaneous on-board epochs and avoids the unstability of the Ultra Stable Oscillator (USO) used as the on-board reference clock. Several ground-to-ground links between SLR stations located in the same regional area (of around 4,000 km wide) were estimated by this method. When H-maser are used as reference clocks by the stations, the stability, the repeatability, and the accuracy of the calibrated CV links are of a few picoseconds (ps) over 100 seconds, of 50 ps over few days, and of 140 ps, respectively. The aims of the present work is to synchronize remote ground clocks (SLR stations) that are in non Common View (between Asia, Europe, America, etc.). In the longer term, the objective is, of course, to calculate this type of time transfer automatically on a regular basis. The main difficulty is to take into account the complex behavior of the on-board oscillator during 1-2 satellite orbital revolutions (1 rev = 6700 s). We show that, by modeling temperature and radiation effects controlled by environmental data (space and satellite), it is possible to ensure a relative frequency stability of a few 10^{-13} over this kind of period. First results show that the SLR stations of the network are not currently synchronize to UTC at the 100 ns level as recommended by ILRS. The noise which is introduced by unknowns (as the non deterministic behavior of the USO) is estimated at a few nanoseconds over one rev. We intend to organize a dedicated campaign including at least 4-5 SLR stations: Grasse and Herstmonceaux, Mac Donald, and Changchung and Koganei. Our goals are first to estimate the repeatability of each link over few days and then, by making the necessary calibrations of each site (for SLR and for GPS if any), to establish their accuracy including by making comparison with GPS.